# REVEGETATION: THE SOFT APPROACH TO ARCHEOLOGICAL SITE STABILIZATION

**By**

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## INTRODUCTION

This Technical Brief is the third in a series that addresses the issues of archeological site stabilization and protection. Each Technical Brief in the series describes a potentially useful technique for maintaining the integrity of an archeological deposit. This series, and the complementary Technical Notes assembled by the U.S. Army Corps of Engineers Waterways Experiment Station in its Archeological Sites Protection and Preservation Notebook, are designed to provide baseline data for the initiation of site stabilization projects. The use of vegetation always should be considered a viable means of site protection when developing a set of stabilization alternatives.

## REVEGETATION HISTORY

Archeological sites throughout much of the United States have been covered with some form of vegetation since they were abandoned by their original inhabitants. Carefully planned revegetation of such a site will not constitute a previously unknown intrusion into the cultural deposit. Such major earthworks as those at Cahokia, Emerald, the Pharr Mounds (Figure 1) on the Natchez Trace, and the Great Serpent Mound have been maintained through the use of floral cover (Thorne, Fay, and Hester 1987). More recently, the Albany Mound group in Illinois has been stabilized through a program of vegetation removal and replacement (Brown 1983), and the Petersburg National Battlefield is being protected with a carefully devised landscape management plan (Andropogon Associates 1988, 1989). Part of the Newark Earthworks has been protected through the upkeep of golf course grasses. At the Winterville Mound group in Mississippi (Figure 2), dense stands of tall grass have been used for several years to stabilize the sides of the mounds as well as to direct the movement of visitors around the park.

Revegetation is currently being undertaken as a part of the total site stabilization package at Lake Britton in northern California. Willow (Salix negra) cuttings were put into place on a sloping bank and beneath a midden deposit (Figure 3). Figure 4 indicates the extent of cutting growth after 12 months. Willow was selected for use in this particular setting because the rate of shoreline loss is very slow and immediate protection was not deemed necessary. In this particular instance, as the willows mature and begin to drape over the edge of the lake, mayflies will find a suitable habitat. A secondary benefit of this site stabilization effort will then be the improvement of the local fishery.

## REVEGETATION BENEFITS

The reintroduction of plants on or around an archeological site can be one of the least visually intrusive stabilization techniques available. Careful species selection produces a vegetative cover that blends well with the surrounding environment, and places a site in a more “natural” setting. Properly selected species can also enhance a habitat for the faunal community that frequents the site. As a result, habitat enhancement carries the additional advantage of letting the archeological community develop a protectionist alliance with groups whose primary interests lie outside the area of cultural resource management.

The use of vegetation as a means of achieving site stability can be viewed as a soft approach in comparison to the more traditional engineering approaches such as riprap or revetments. Floral systems have the advantage of being elastic, and species easily can be found that are adapted to a broad range of micro-topographic settings. Vegetation can also effectively dissipate wind and water energy that can destroy a cultural deposit.

Depending on the setting of a specific site, both types of force can come into play. The majority of soil movement that is stimulated by wind action takes place in a zone that extends from the surface of the ground to heights that are below 3 feet. Wind velocities necessary to move soil particles are less than 13 miles per hour at a height of 1 foot above the ground. Once wind-generated soil movement starts, velocities less than 13 miles per hour are likely to be sufficient to continue soil loss. Since 62 percent to 97 percent of soil loss activity occurs in the 3-foot vertical zone closest to the ground, vegetation that exceeds 3 feet in height will serve to filter soil agitated by a driving wind and at the same time lessen the force of the wind (Gray and Leiser 1989:12-13).

The types of water-generated erosion that are most frequently mentioned as impacting archeological deposits are sheet erosion and stream channel erosion. In many areas, lacustrine erosion of sites has a greater impact on archeological materials than channel erosion, but a one-to-one comparison is not possible since two very different kinds of forces are operating to remove the cultural deposit.

Cultural resources managers, including archeologists seldom recognize the impact that rainfall has on unvegetated and unprotected surfaces. Raindrop impact can cause soil particles to move as much as 2 feet vertically and 5 feet laterally on level surfaces and, if a sufficiently steep gradient is present, slope movement of soil can occur (Gray and Leiser 1989:12-13). From the perspective of energy, raindrop impact generates greater kinetic forces than water that causes sheet erosion. Soil movement results from both rain and sheeting water with raindrops serving to dislodge individual soil particles that are then moved farther by the sheet erosion process.

The volume of soil removed through sheet erosion is increased also as a result of frost heave, since this heaving action will uniformly loosen the soil. Some counter-erosion compaction occurs as rain falls on unprotected soil, but the rate of compaction is not sufficient to prevent sheet erosion from occurring.

The destructive force of various forms of erosion can be lessened, if not completely stopped, in many situations through the use of carefully selected vegetation. As the lateral roots of vegetation spread and intermingle, the soil becomes bound together and acts like a composite material. Stresses in the soil are transferred to the root fibers, which have relatively high tensile strength, and in this manner the soil is reinforced and strengthened (Gray and Leiser 1989:39).

In aquatic environments where moving water pressures and fairly constant on the vegetation, a well established stand of grass will react accordingly and can reduce stream velocity and wave forces by as much as 90 percent (Keown, Oswalt, Perry, and Dardean 1977:59). Mitigation of lateral shear force is accomplished by a variety of plants through the development of special stabilizing tissue and root stiffening and strengthening (Schiechtl 1980:208). Mechanical stabilization techniques do not exhibit this self-regulating capability, nor are they pliable.

Budgetary constraints make the use of vegetation an especially attractive choice because of the low cost of initial installation and post-placement maintenance. In addition, plantings can be used in combination with a number of mechanical stabilization techniques and further strengthen the mechanical installations. In most cases, no special labor expertise is required to put plantings in place, and labor costs can be held at a minimum. Plant installation is, however, a labor intensive operation.

When necessary, vegetation can be reestablished without disrupting a cultural deposit by using seed-bearing spray mulches or by seeding beneath biodegradable mats. The use of mulches and matting can add a appreciably to the cost of a revegetation effort. As a cost cutting measure, used carpeting can sometimes be substituted for matting at no cost. Frequently, planting materials such as willows can be obtained locally, which can further reduce installation costs.

Plant materials have the additional advantage of adapting to a wide variety of environmental conditions and topographical features. Maiden cane (Panicum hemiomom Schult.), which has been tested for its capabilities as a mechanism for erosion control, will grow in shallow water, across a shoreline, and up a bank for a short distance (Young 1973). Similarly, species can be obtained that will grow on dry soils (Haffenrichter, et al. 1968;U.S. Department of Agriculture 1976), on sand dunes (Knutson 1977), and in rocky or badly disturbed terrains (Vogel 1981). Some degree of control of ultimate plant height can be exercised during the plant selection process, and important anti-looting protection can also be obtained through careful plant selection.

Once established, a protective live vegetative cover requires little or no maintenance. Grasses can be managed through hay-cutting. In addition to maintaining an attractive appearance, haying has the potential of being a no-cost operation that could generate a portion of the site's maintenance funds.

## REVEGETATION LIMITATIONS AND LIABILITIES

Revegetation, like other stabilization techniques, is not without its own set of liabilities, and these must be carefully considered and weighed against its advantages. An assumption that must be accepted as a part of most stabilization projects is that, since a significant resource is being lost, some negative effects resulting from the stabilization effort are acceptable and preferable to the continuing loss of the site. In a revegetation effort a small amount of additional site loss can be predicted before the plantings reach their maximum protection potential.

### Root Disturbance

The most frequently voiced objections to site revegetation center around the intrusion of roots into the cultural deposit. Beyond doubt, root growth can disrupt and contaminate what may appear to be an otherwise undisturbed deposit. With the exception of historic and late prehistoric sites, forests and grasslands have covered many of the sites in North America, and such site contamination and disruption has already taken place.

The potentially negative impacts from a revegetation program can be recognized, and ways to deal with those impacts can be identified during the project design process. Perhaps the best approach to problem solving in planning for revegetation stabilization is to recognize two broadly defined kinds of disruptions. One may be of a physical nature while the other may be bio-chemical.

Within the context of an archaeological deposit, physical disruption includes the lateral and vertical displacement of artifacts and biofacts and the interruption of the general continuity of the archeological deposit. Bio-chemical disruption stems from changes in soil pH, changes in the hydrological characteristics of the cultural deposit, and changes in the microfaunal community, which could in turn alter the chemical constituency of the deposit.

The majority of the physical disruptions that a site experiences from revegetation derives from the root systems of the cover species. The depth and lateral spread of various plants is species-specific, as some species are more deeply rooted than others, while some species have a greater lateral distribution of the supporting roots (Meyer and Anderson 1939;266-267). However, knowledge of the variability of root system development for specific species is not sufficient to allow prediction of root growth and the concomitant potential for site disturbance. Other factors, many of which are specific to site location, must be taken into account. Among these are depth of the water table, the presence of a subsurface hardpan, buried sand strata, and gravel deposits.

Primary root systems, such as taproots and the laterals that radiate from them, are likely to cause the most site disruption since these are the largest roots in a complex. The secondary root system of most species is threadlike or fibrous and generally too small to pose any displacement problems. These smaller roots do have the potential of invading small spaces in artifacts, bone, and charcoal, and in sufficient numbers of size can wedge these materials apart. This kind of potential destruction is likely to be minimized since the nature of these roots is such that impenetrable, non-nutrient bearing substances will cause the roots to grow in another direction (Laycock 1967; C21-C22). By the same token, if archeological material is not cracked or broken, the potential wedging action of secondary roots is not likely to pose a problem. Primary roots are generally of sufficient size that artifacts will be displaced rather than broken or destroyed by them.

Perhaps the most destructive physical impact that floral cover can have on an archeological deposit comes from overturned trees. Since the majority of the primary root system of most trees is within the first few feet below the surface of the ground (Meyer and Anderson 1939;267), blowdowns are likely to pull large chunks of soil and artifacts from a cultural deposit. Tree throws can produce large holes that are subject to being refilled by accumulated leaves and the materials that were pulled up by the falling tree. This material must be accounted for in subsequent scientific excavations.

This points out the care that should be exercised in the selection of species to be used in revegetation projects. Species of larger vegetation such as trees that have heavy crowns with broad lateral root systems should generally be avoided. Similarly, species that have massive and deep root systems should be avoided to insure that deep disturbance is minimized.

**Bio-chemical Disruptions**

Bio-chemical destruction of archeological materials that may result from revegetation seems to be much less of a problem than site destruction from physical forces. The chemical composition of the leaf fall of different plant communities varies according to the predominant species of the community and will vary somewhat within a community depending on the volume of litter produced and the age of the dominant species. Soil pH is controlled by plant litter to a relatively shallow depth, being principally confined to the humic zone, while the pH of soils beneath the humic layer reflects the petrographic nature of the substrata (Braun-Blanquet 1932:245).

When a plant community changes as a result of increasing numbers of an invasion species, soil pH may change to reflect the character of the invaders. In so far as the archeological component is concerned, these are minor changes since they are largely confined to the humic zone and will have little impact on the soils that lie below. Principal changes occur in soil pH and in the organic matter content. Plant health, and ultimately the success of a revegetation effort, is dependent on the presence of nitrogen, phosphorus, and potassium and appropriate H-ion concentrations.

The extent to which amounts of nitrogen, phosphorus, and potassium adequate for successful plant growth can alter artifacts seems to be largely unknown. One must suspect that the presence of these chemicals has little effect, given the excellent state of preservation of artifacts in heavily vegetated sites. It is worth noting, however, that when levels of decaying organic matter become sufficiently high, carbonic and nitric acids are produced in quantities that are sufficient to release phosphorus that is present in parent soils (Longsdon 1975:58). Carbonic and nitric acids are thus present in most decomposing leaf and stem litter and may account for alterations in soil/site matrix pH.

Higher concentrations of the H-ion, which are dependent on the decomposition of plant litter, occur in the very top layer of the O horizon, from 1 centimeter to 2 centimeter. As the depth below this zone increases, H-ion concentration decreases and the pH of the soil remains stable (Braun-Blanquet 1932:173). At varying depths below the A-1 horizon, depending on the depth of soil development, pH is controlled by moisture and the characteristics of the underlying bedrock, and not on the decomposition of plant litter.

While Mathewson (1989:230) addresses the issue of site burial specifically, his archeological component/preservation matrix provides some insight on the effects of acidic versus basic environments with regard to artifact loss. If soil conditions are altered from basic to acidic, an acceleration of the rate of loss of certain kinds of archeological remains will occur. Since changes in soil pH occur in the humic zone (0 horizon) and in the upper portions of the A horizon when cover species are added or changed, leaching is likely to dissipate any significant acid accumulation. Artifactual materials in and beneath the A horizon are not likely to be altered at an increasing rate as a result of decomposing organic debris on the surface.

Climate and topographic characteristics affect the production of organic matter in soils while various soil types also affect the accumulation of organic matter. Generally, forest soils derive their organic matter content from leaf fall, since tree roots usually live for many years and decompose slowly. The upper 6 inches of a soil will contain the highest concentrations of organic matter, largely as a result of movement by insects, worms, and small animals that live in the A horizon. Below the first foot of depth, soil organic matter content is about 1 percent by volume, and organic matter is virtually absent at a depth of 4 feet.

The relationship between organic matter content and soil depth for grassed areas is similar to that of forested areas. At the O horizon level organic matter is about 5 percent by volume, at a depth of 1 foot it is about 1 percent, and at a depth of 4 feet it is only about 0.1 percent (Thompson and Troeh 1957:126-130).

The introduction of vegetation or the revegetation of an archeological site will have little effect on its organic matter content, assuming that the site has had an existing floral cover. On completely denuded surfaces, it will take several years for organic matter to accumulate, and this will be related to the presence of quantities of nitrogen sufficient to allow plant growth (Thompson and Troeh 1957:131). The addition of chemical nitrogen may prove to be necessary to ensure successful revegetation.

Given the low levels of soil organic matter below the A horizon, the loss of artifactual materials should not be accelerated.

## PROJECT PLANNING

Even though revegetation projects can be put into place in relatively short periods of time, project development and implementation sometimes require a relatively long preparation time. Plant selection, acquisition, and placement must occur during periods of plant dormancy to insure maximum survival once the growing season begins. Freeze/thaw cycles, periods of dry weather, and disease can lead to plant loss. Notice should be taken of potential plant toxicity for the crews who will make an installation. Commonly seen plants such as English ivy cause allergic reactions in some people.

While not directly a concern for stabilization projects, care must be exercised to protect against the introduction of species that might ultimately become weeds. The best approach to a revegetation program is to try to select species that are native to the vicinity of the stabilization project. If a non-native or commercially supplied species is to be used, careful consideration should be given to the background of the planting material selected.

### Sources of Plant Data and Planting Guidelines

While a wide variety of data that deal specifically with revegetation is available, information is scattered and sometimes difficult to acquire. Schiechtl's (1980) Bioengineering for Land Reclamation and Conservation is an excellent source of information on planting techniques and the range of microenvironments that can be stabilized by revegetation. Much of the background data Schiecctl uses is from Europe, and many of the species that he recommends are not indigenous to North America. Similar species do occur in the United States, however, and substitutions can be easily identified.

The most readily available source of revegetation data has been developed by the Soil Conservation Service (SCS) of the U.S. Department of Agriculture. Some information is available from the regional SCS Plant Materials Centers. These organizations are responsible for the testing and development of species that are suited for stabilization in their respective regions. Prior to 1969, SCS prepared several handbooks on stabilization issues that provide regionally specific data.

Other sources of revegetation and stabilization data are the U.S. Forest Service and the U.S. Army Corps of Engineers (COE) laboratories, particularly the COE Waterways Experiment Station. The COE reference works generally deal with streambank and lakeshore erosion, in contrast to the work of the SCS, which deals with both wet and dry environments. Maritime erosion problems are dealt with by the COE and the Shore Protection Manual (1984), which is a highly technical source of stabilization data. SCS publications are also available for coastal areas.

Local and regional SCS offices can provide support in making planting selections as well as determining fertilizer and lime requirements for revegetation projects. Soil pH requirements for maximum growth will vary by species, and soil testing should be completed after the plants have been selected. In this manner, a fertilization and liming plan can be devised that will be suited to the selected cover plantings. At the same time, a maintenance schedule for fertilization can be developed. From that schedule future maintenance costs can be projected.

## INSTALLATION COSTS

Stabilization projects that employ revegetation as the primary technique can provide one of the most cost-effective means of site protection available. This is true not only for initial installation but for long-term maintenance as well.

Cost projections for a program of revegetation should include plant purchase costs if the species to be installed cannot be collected. If collection is possible, projected labor costs must include not only the time needed to install the materials but collection time as well. Neither of these tasks requires skilled labor, so costs can be minimized. If purchasing of materials is required and the materials must come from some distance, shipping charges may add significant cost.

### Request for Assistance

Information exchange about site stabilization is available from and should be reported to: **Dr. Robert M. Thorne, National Clearinghouse for Archaeological Site Stabilization, Center for Archaeological Research, University of Mississippi, University, MS 38677.**

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1989 – Earthworks Landscape Management Manual; Section I.  Prepared for the Mid-Atlantic Regional Office, National Park Service, Philadelphia, PA

This manual's primary focus is to develop management strategies and interpretive guidelines that resolve current conflicts between the requirements for preservation and the impacts of interpretation and visitor use at earthwork sites.  The manual is intended to serve as a guide for all earthworks in the National Park Service (NPS) system and for a application to similar environments within the NPS system with limited study.  A major observation noted during the review of the sites evaluated for the preparation of the manual was that earthwork sites stabilized by healthy, native plant communities are in the best condition, while some current management practices have contributed directly to the degradation of the resources.  The manual is divided into two major sections.  The first section is a review and evaluation of current management practices and an assessment of present vegetative cover types.  Recommendations are made for an overall management program aimed at integrating preservation and interpretation objectives.  The second section begins with procedures for evaluating and monitoring a site with respect to the proposed guidelines.  Since many of the management techniques focus on native plant communities, the management of which is unfamiliar to many park employees, workshops at various levels of NPS employees were held.  Actual hands-on instruction sessions were used as a means of both teaching park employees how to use the soil bioengineering techniques and to begin restabilization and revegetation on damaged ground surfaces that needed immediate attention.  Critical to the soil bioengineering techniques is the need to prioritize problem areas to include both short term and long term management practices.

Brown, Margaret K.

1983 – Mothballing Albany Mounds, American Archeology (formerly Contract Abstracts and CRM Archeology) 3(3).

The Albany Mound site consists of some 40 to 50 mounds and 3 village areas and is owned by the Illinois Department of Conservation. Preservation of the site, with a very limited budget, was a multidisciplinary effort. Invasion species were removed from the site, and prairie grasses, brush, and trees that would have been a part of the original prairie community were left to grow to maturity. Management of the prairie environment will be through controlled burns, and the expense of maintenance will be minimized.

Hafenrichter, A.L. John L. Schwendiman, Harold L. Harris

1968 – Grasses and Legumes for Soil Conservation in the Pacific Northwest and Great Basin States. Agricultural Handbook 339, Soil Conservation Service, U.S. Department of Agriculture, Washington, DC

Knutson, Paul L.

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Beach grasses have been used to stabilize dune systems. Techniques are available to propagate beach grasses. Guidelines for selecting plants and planting methods, obtaining plants, storing, planting and maintaining plants, and estimating labor requirements for dune vegetation projects are included.

U.S. Department of Agriculture

1976 Plant Materials Study: A Search for Drought Tolerant Plant Materials for Erosion Control, Revegetation, and Landscaping Along California Highways. Soil Conservation Service Research Project, USDA/SCS LPMC-1, Davis, CA.

Plant materials were assembled, propagated, and established along California State highways. Grasses, legumes, and the California poppy were evaluated for erosion control, fire control, and aesthetic purposes. Shrubby species were evaluated for revegetation and general landscaping. Emphasis was placed upon drought-tolerant, low-growing plants that would require a minimum of maintenance. A herbaceous seeding guide and a list of native shrubs and trees were prepared for California, classified by major land resource areas. Special and supplementary studies relevant to plant propagation and establishment were conducted. Whenever possible, the plants were evaluated on representative highway sites using common methods applied by contractors. Most data were collected by visual observation; no statistical analyses were made beyond simple arithmetic averages. Some continued monitoring of plantings is recommended to assess anticipated future changes.

Vogel, Willis G.

1981 – A Guide for Revegetating Coal Mine Soils. General Technical Report NE-68, U.S. Forest Service, Northeastern Forest Experiment Station, Berea, KY.

This report provides information, recommendations, and guidelines for revegetating land in the Eastern United States that has been disturbed by coal mining. Included are brief descriptions of major coal mining regions in the East, a discussion of mine soil properties, and procedures for sampling, testing, and amending mine soils.  Plant species that have been used for revegetating surface mined lands are identified and described.  Selection criteria for plant species and methods and requirements for seeding and planting are explained.  Some of the data on tree species used in reforestation were obtained from recent surveys of 30-year-old experimental plantings in several Eastern States.  Included are maps showing the Eastern coal regions or portions of them where a plant species has been used successfully or its use is recommended.

Young, W.C.
1973 – Plants for Shoreline Erosion Control in Southern Areas of the United States, modified by W.C. Ackeman, G.F. White, E. B. Worthington.  In Man-Made Lakes:  Their Problems and Environmental Effects.  Geophysical Monograph Series No. 17.  American Geophysical Union.

This paper discusses various species of plants that have been tested for their adequacy in Stabilizing eroding shorelines.  Maiden cane is specifically identified as a good choice for Protection objectives that extent across waterlines.